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ABSTRACT

This paper examines what has been learned from research about the complex connections between literacy, technology, and learning. The beginnings of research in this area coincided with the introduction of personal computers (PCs) into educational settings in the late 1970s. For the first decade, researchers asked the kinds of questions best explored using quantitative methods. They set out to determine whether the use of computers enhanced writing. The findings, however, were equivocal. By contrast, sociocultural understandings of literacy, which became more widely accepted in the mid-80s, provoked a different research orientation and different kinds of questions. The Digital Rhetorics project (Lankshear, et al 1997) is an example of research informed by the recognition of literacy as social practice. Further, it exemplifies the shift towards qualitative research approaches in the field of literacy and technology studies. The paper includes an overview of the Digital Rhetorics project, giving particular attention to its sociocultural perspective and qualitative methodology. Finally, it considers future directions for research and practice in this area. The paper concludes that a maturing of the field of literacy and technology studies has been reached. The research agenda is fertile with possibilities. The challenge is to undertake studies that will continue to inform effective practice, mediated by new communication and information technologies, at all levels of education. Contains 60 references. (Author/RS)

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Literacy and technology studies: past, present, future

Ilana Snyder

Abstract

In this presentation, I examine what we have learned from research about the complex connections between literacy, technology and learning. The beginnings of research in this area coincided with the introduction of PCs into educational settings in the late 1970s. For the first decade, researchers asked the kinds of questions best explored using quantitative methods. They set out to determine whether the use of computers enhanced writing. The findings, however, were equivocal. By contrast, sociocultural understandings of literacy, which became more widely accepted in the mid-80s, provoked a different research orientation and different kinds of questions. The *Digital Rhetorics* project (Lankshear et al 1997) is an example of research informed by the recognition of literacy as social practice. Further, it exemplifies the shift towards qualitative research approaches in the field of literacy and technology studies. To provide a context for the concurrent sessions and panel discussion that follow mine, I include an overview of the *Digital Rhetorics* project, giving particular attention to its sociocultural perspective and qualitative methodology. Finally, I consider future directions for research and practice in this area. We have reached what could be called a maturing of the field of literacy and technology studies. The research agenda is fertile with possibilities. The challenge is to undertake studies that will continue to inform effective practice, mediated by new communication and information technologies, at all levels of education.

Bio-details:

Dr Ilana Snyder is a Senior Lecturer in the Faculty of Education, Monash University. Her teaching and research focuses on the new literacies and changes to pedagogical practices associated with the use of digital media and telecommunication technologies. Two books, *Hypertext: the electronic labyrinth*, (Melbourne University Press 1996) and *Page to screen: Taking literacy into the electronic era* (Allen & Unwin 1997), explore these changes. She was one of the team of nine investigators in the DEETYA-funded literacy and technology research project, *Digital Rhetorics* (Lankshear et al 1997). With Colin Lankshear and Bill Green, she has co-authored *Teachers and Technoliteracy: Managing literacy, technology and learning in schools*, which draws on the final report. It will be published by Allen and Unwin in March 2000.

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Literacy and technology studies: past, present, future

Ilana Snyder

The research challenge

We have entered a new era in literacy research. New technologies have radically altered everyday modes of communication. Indeed, they are becoming so fundamental to society that most areas of social practice in day-to-day life are affected by the so-called 'information revolution'. In a world increasingly mediated by communication and information technologies, literacy researchers simply cannot afford to ignore the implications of the use of new technologies for literacy practices.

Much has been written and said about the information revolution, with varying degrees of clarity. Discussions of the impact of the new technologies are often clouded by hype. Enthusiasts openly embrace the technologies, claiming they offer a panacea for educational problems, enhance communication, empower users, and democratise classrooms. At the opposite extreme, 'demonisers' exude cynicism about the technologies' apparent powers. Some dismiss them simply as new instructional and communication tools. Others reject them outright as yet a further form of social control or enforced consumption, which promotes the interests of state and corporate sectors. Clearly, extreme responses are of limited use, and the need to move beyond them increasingly urgent in education.

The challenge for literacy researchers is to extend and enhance understanding of the ways in which the use of new technologies influences, shapes, perhaps transforms, literacy practices. Whether the changes to the literacy landscape we are witnessing represent an extension of the ways in which we do literacy or something altogether different, changes are happening. We need to investigate the nature of these changes to literacy practices and find illuminating ways to theorise them that are useful for teachers.

The challenge for literacy teachers is to understand the changes and to learn how to use the new technologies efficiently, ethically and responsibly with a view to tapping their educational potential. This means that teachers need to realise that there is not much point in trying to accommodate new technologies to existing classroom approaches to literacy education, as such teaching merely ends up looking much the way it always has except more 'technologised'.

A number of questions quickly arise around the role and significance of new technologies in literacy education. These include:

- How are literacy and technology related?
- What are the emergent literacy practices associated with the use of new communication and information technologies?
- How can literacy researchers make sense of the relationship between literacy and technology to develop sound theoretical understandings that may inform effective pedagogical practice at all levels of education?

These and similar questions are at the heart of the literacy and technology studies research agenda. Such an agenda, however, does not exist in a vacuum. It needs to take account of global, national and local political trends and policy emphases, integral to the environment in which researchers do their work. At a pragmatic level, these trends and emphases go some of the way in determining which research projects and programs receive government and institutional funding and which do not.

The trajectory of the research

Research investigating the connections between literacy, technology and learning began in the late 1970s. The early 'computer-writing' studies were most often quantitative, experimental in conception and design. There was a gradual shift in the 1980s to qualitative methods, with an emphasis on the socially constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situational constraints that shape inquiry. More recent studies have adopted multiple perspectives which draw on methods from both quantitative and qualitative traditions, while others examine computer-mediated literacies through a particular ideological lens.

It would be a mistake, however, to represent the three decades of research in this area as a process of evolution. Each of the earlier waves are still operating in the present as a set of practices that researchers follow or argue against. An array of choices now characterises the field with no single approach privileged. Of course, there are no less problems and difficulties, particularly in studies which attempt to blend methods from different paradigms. Inevitable are tensions between traditional, positivist conceptions and relativist, postmodern approaches to research in this area (Snyder 1997a).

There are a number of useful overviews of the research, extending in their coverage, however, only to the mid-1990s (Bangert-Drowns 1993; Snyder 1993a; Hawisher, LeBlanc, Moran & Selfe 1996). As well as establishing what we already know about students, their literacy practices and the use of new technologies and suggesting what we still need to find out, they highlight the difficulties of interpreting studies that reflect contrasting conceptual frameworks and which differ in design, methods of data collection, variables examined and modes of analysis.

What we have learned from research

The first studies coincided with the availability of micro-computers and word processing software in educational settings (Gould 1978). Investigators asked the classic question in educational research: Does this innovation improve things? They chose the traditional method of exploring it – empirical - although case study was also used (Catano 1985). Experimental and quasi-experimental studies assessed whether the quality of texts produced with computers was better than those produced with pens. Chiefly through the perspective of cognitive psychology, early research also examined the effects of the use of computers on composing processes, particularly prewriting and revising. Implicit was the conviction that if students planned carefully and revised more with computers, their texts would be better (Daiute 1986).

By the mid-80s, there emerged a shift in focus from the isolated writer to the writer in context. With this increased sensitivity to the sociocultural setting in which the computers were used, studies became more distinctively ethnographic (Dickinson 1986; Herrmann 1987). This variation in research method was accompanied by a new teaching emphasis. Still interested in the effects of word processing on writing quality, revision and attitudes, studies concentrated on the writing pedagogy, often a process approach, that teachers adopted when introducing the technology. The computer was investigated as a potentially felicitous tool that might both facilitate and enhance a process approach (Sommers 1985).

The research was in transition: some researchers were operating in the current-traditional paradigm, concerned with quality, correctness and error; many were operating in the writing-process paradigm; and a few were beginning to adopt the social view (Hawisher, LeBlanc, Moran & Selfe 1996). Not surprisingly, the results of the quality-focused studies were equivocal. There is probably a short answer to the question: Do students write better with computers? It depends - on the writer's preferred writing and revising strategies, keyboarding skills, prior computer experience, supplementary teaching interventions, the teacher's goals and strategies, the social organisation of the learning context and the school culture (Bangert-Drowns 1993). Studies which examined the effects of word processing on revision strategies reported an increase in the frequency of revision. Studies in which word processing was combined with effective writing pedagogy produced uniformly positive findings: when instruction involved teaching students strategies aimed at improving their writing skills, writers using word processing achieved at a higher level than similar writers not using computers (Sommers 1985; Daiute 1986). When computers were considered by researchers as part of a dynamic, integrated classroom environment (Dickinson 1986; Herrmann 1987), the findings were consistently positive. Computer-produced writing achieved higher ratings (Herrmann 1987); collaboration and writing-focused talk were facilitated (Dickinson 1986); classrooms were less teacher-centred (Herrmann 1987); and writing was transformed from a private to a public activity.

The mid-80s marked the end of the first generation of research and the beginning of a second. The research consolidated but researchers also began to explore the possibilities of the computer as a site for the social construction of knowledge. Shifts in interests and methods can be identified: feminist criticism, cultural criticism and critical pedagogy were all used to frame and inform research; the war between quantitative and qualitative approaches abated; and the researcher was increasingly understood as implicated in research processes.

The contextual approach to computers and their use (Kramarae 1988) made gender issues central to discussion of technology. Early research on computers and gender focused on women's exclusion from the computer revolution (Gerrard 1999). Women and girls of the 1980s and 1990s were found to be anxious about computers (Collis 1985); unchallenged by the unstimulating assignments and lack of hands-on experience they received in school (Levin & Gordon 1989); discouraged from pursuing a career in technology (Abtan 1993); stereotyped as phobics in advertising (Hawkins 1985).

By contrast with the studies which exposed women's problems of access to computers and computer culture, there has also been research that has examined gender from a broader perspective. Studies have suggested ways to inform the computer-based classroom with feminist pedagogy (Selfe 1990); considered the computer conference as a medium that promotes or shuts out women's voices (Flores 1990; Romano 1993); investigated girls' use of the Internet (Kaplan & Farrell 1994). The most contemporary studies take account of the factors that have alienated women from computer technology, but focus more on 'how gender influences what men and women are doing with computers and what this technology is doing for them' (Gerrard 1999, p. 1).

More generally, there was the growing recognition that computers in classrooms appear 'unlikely to negate the powerful influence of the differential socialisation of students by social class and its effects on their success or failure in school' (Herrmann 1987, p. 86). In fact, the contrary may be the case. It may be that computers in classrooms make the impact of students' differential socialisation and enculturation experiences more severe. For example, a Scandinavian study (Staberg 1994) shows that adolescent girls are rejecting computers in disproportionate numbers, presumably because of their lack of sympathy for the control ideology that drives the construction and invention of computers, and because of the obstacle to quality interaction between people that they often erect.

As researchers were no longer simply concerned whether the use of technology makes things better, they asked different kinds of questions which influenced the research methods they used. Researchers argued that we cannot understand how electronic technologies affect students' literacy practices 'apart from the ways these are embedded within, and mediated by, the social systems of [particular] classrooms' over time (Cochran-Smith, Paris & Kahn 1991, p. 107). Qualitative methods, including observation and interviews, seemed the best way to investigate such questions: Cochran-Smith et al (1991) worked with teachers and students in five elementary classrooms over two years to explore how computers made learning to read and write different; in a case study that involved active participant observation, Miller and Olson (1994) found that the existence of innovative practice associated with the introduction of computers in the classroom has less to do with the advent of technology than with the teacher's pre-existing conception of practice. Slattery and Kowalski (1998) examined the writing processes first year and upper-level college students develop when they compose on screen. Their findings suggested that students can learn and adopt differing types of writing strategies and in doing so begin to conceptualise written text in new ways.

However, at the same time, some researchers continued to investigate the influence of word processing on writing quality and revision strategies, but attempted to avoid problems encountered in earlier studies. The findings were correspondingly more persuasive: when the student subjects were experienced users, papers written on computer were rated higher (Owston, Murphy & Wideman 1992); when students with different writing abilities were observed, the effects of word processing interacted with individual student differences (Joram, Woodruff, Bryson & Lindsay 1992); when genre was taken into account, students using computers were awarded higher scores than those using pen for argument and exposition, but not for narrative (Snyder

1993b); when similar groups of student writers were compared, the group which received unsolicited metacognitive guidance from a specially designed computer tool wrote better essays (Zellermayer, Salomon, Globerson & Givon 1991).

Increasingly, researchers examined what is now widely known as computer-mediated communication (CMC). This form of interaction is made possible when computers are used to create electronic forums on local-area networks (LANs) and wide-area networks (WANs). It has been noted that these electronic spaces in which writers and readers can create, exchange, and comment on texts have the potential for supporting student-centred learning and discursive practices that can be different in form, and, some claim, more engaging and democratic than those in traditional classrooms (Batson 1988).

Most of the studies of CMC are with post-secondary students, however, the findings still have implications for school-based research. Researchers have undertaken comparative observational studies of college students engaged in both face-to-face discussions and electronic exchanges about their writing (Palmquist 1993; Geest & Remmers 1994; Yagelski & Grabill 1998). Palmquist concluded that the use of networked-based communication both shaped and was shaped by the curricula and that the interaction between networked-based communication and face-to-face may lead to better academic performance. By contrast, Geest and Remmers concluded that computer-mediated peer review had many of the drawbacks of 'distance learning'. Similarly to Palmquist, Yagelski and Grabill identified a complex relationship between online discourse and in-class discourse within the context of a specific course. Their results suggest the importance of understanding course-related online discourse within the context of a university program and undergraduate student experience.

Hypertext, fully electronic non-sequential reading and writing, has also been a focus of research interest. Writing about hypertext was initially dominated by explications of the technology's convergence with contemporary literary theories (Snyder 1996). Claims have also been made for hypertext's educational potential (Snyder 1996; Russell 1998). These include the promotion of more independent and active learning, changes to teaching and curriculum practices, and challenges to our assumptions about literacy and literary education. Theoretical work on the connections between hypertext and postcolonial theory (Odin 1997; McConaghy & Snyder 1999) explores shared characteristics of both discourses: multivocality, multilinearity, open-endedness, active encounter and traversal. Theoretical work on the connections between hypertext and feminist theory (LeCourt & Barnes 1999; Sullivan 1999) argues that writing multivocal hypertexts can help make students more aware of the multiplicity of their subject positions and the ways in which academic contexts try to silence these positions.

The Internet has become a site for research. New literacy practices (Burbules 1997; Sorapure, Inglesy & Yatchisin 1998); issues of identity (Turkle 1995; Alexander 1997); class and access (Castner 1997; Richardson 1997; Grabill 1998); the maleness of the Web (Takayoshi, Huot & Huot 1999) have been the focus of investigations. Research has emphasised the need to teach students how to assess the reliability or value of the information they find on the Web by understanding not only its textual

but also its non-textual features such as images, links and interactivity (Burbules & Callister in-press).

Analysis of policy trends and emphases has increasingly provided the focus of research in the field of literacy and technology studies. In her examination of the American policy environment, Selfe (1999) points out that many literacy teachers continue to regard technology as antithetical to their work, but argues that they can no longer afford to ignore it. According to Selfe, failure to do so sustains and reproduces an unfair system that 'ensures continuing illiteracy under the aegis of education' (Selfe 1999, p. 415). Snyder (in-press-a) highlights an apparent contradiction within the Australian policy environment. At the federal level, literacy policies often reflect reductive and anachronistic approaches to literacy education while at the state level, policies exhort teachers to technologise the curriculum in order to prepare students for the sophisticated literacy demands of a knowledge-based economy and an information-rich society.

The *Digital Rhetorics* project

The *Digital Rhetorics* project exemplifies the shift towards more qualitative research approaches that emerged in the mid-1980s. Further, it represents an important example of research informed by the recognition of literacy as social practice. The two-year, national study investigated the relationship between literacy and technology in teaching and learning (Lankshear et al 1997). It focused on three main elements:

1. an investigation of technology and literacy practices in a range of learning contexts, mainly primary and secondary classrooms;
2. a study of selected key policy documents concerned with teaching and learning in relation to literacy, technology and learning; and
3. the development of a theoretical position to inform the approach to the study as a whole and the recommendations resulting from the investigations.

The project was conducted by a research consortium, with members from New South Wales, Queensland, Victoria and Western Australia, under the joint leadership of Colin Lankshear and Chris Bigum. It was funded by the Department of Education, Employment, Training and Youth Affairs through the Children's Literacy National Projects Program.

The study adopted the stance that in the context of increasing and changing demands for literacy and technology learning worldwide, education must enable students to become proficient in the 'operational', 'cultural' and 'critical' dimensions of literacy and technology. This includes understanding how contemporary economic, social, technological, administrative, organisational and political changes are impacting on social practices of literacy, technology and learning – changing them and the relationships among them. That they are making an impact is undisputed; less clear are the kinds of literacies important in this context of change. They potentially include skills in the visual media associated with most technological applications, together with many new communication and information literacies.

Within the constraints of this paper, it is impossible to do justice to all three aspects of the study. I have decided to elaborate the three-dimensional approach to literacy and technology and to then concentrate on the site studies which represent the empirical core of the project. Readers interested in learning more about the theoretical work of the study, as well as the literacy and technology policy analysis, are referred to the four-volume report (Lankshear et al 1997) and to the book, *Teachers and technoliteracy: Managing literacy, technology and learning in schools*, which will be published by Allen and Unwin in March 2000 (Lankshear & Snyder, with Green in-press).

The sociocultural approach to literacy that informed the research

Integral to a sociocultural approach to literacy is the understanding that literacy is more than the capacity to encode and decode - to grasp meanings inscribed on a page or a screen, or within an established social practice (Street 1984). Being literate also involves the capacity and disposition to scrutinise the practices and universes of meanings within which texts are embedded. Being literate entails the capability to enter actively into creating, shaping and transforming social practices and universes of meanings in search of the best and most humane of all possible worlds.

In opposition to reductionist and mechanistic views of literacy and learning, a sociocultural perspective argues that technoliteracy, seen as social practice, has three dimensions: the 'operational', 'cultural', and the 'critical' (Green 1988). The 3D model exhorts researchers and practitioners not to focus simply on 'how-to' knowledge, understood as technical competence and 'functional literacy'. Instead, researchers need to build understandings which complement and supplement such knowledge by contextualising it in ways that pay due attention to matters of culture, history and power and recognise that it is counter-productive to start with issues of 'skill' or 'technique', outside of an 'authentic' context of situated social practice (Durrant & Green 1998; Lankshear & Snyder, in-press).

The 'operational' dimension of literacy education involving new technologies, focuses on how to operate the language system as well as how to operate the technology system. With respect to the language system, this involves learning how to make it work for individuals' own meaning-making purposes. With respect to the technology system, it involves learning how to make a computer operational, how to 'turn it on' and make it 'work'.

Understanding and being able to draw upon the 'cultural' dimension of literacy involves realising that the ability to operate language and technology systems is always in the service of participating in 'authentic' forms of social practice and meaning. People always use texts and technologies to do things in the world, and to achieve their own, and others', purposes, whether in the context of school, work or everyday life. This means putting the emphasis on 'authentic' contexts, forms and purposes, of learning along the axes of literacy and technology and text and information.

The 'critical' dimension means that teachers and students need to be able to assess and evaluate software and other technology resources in a spirit of informed scepticism (Snyder 1997b; Durrant & Green 1998; Lankshear & Snyder, in-press). That is, they

need the ability not only to use such resources and to participate effectively and creatively in their associated cultures, but also to critique them, to read and use them against the grain, to appropriate and even re-design them, as well as to be able to actively envisage and contribute to transforming social practices as they judge appropriate.

Understanding the 'operational', 'cultural' and 'critical' dimensions of literacy includes getting a handle on how contemporary economic, social, technological, administrative, organisational, and political changes are affecting the social practices of literacy, technology, and learning. It also includes understanding how these changes are altering literacy, technology and learning and the relationships among them. Further, it incorporates understanding how current changes are placing new 'premiums' on literacy, technology and learning - raising them to new heights of urgency.

Most importantly, understanding the 'operational', 'cultural' and 'critical' dimensions suggested to the *Digital Rhetorics* research team how to frame research questions about the changes to literacy practices associated with the use of new technologies. The project aimed not to focus just on 'how-to' knowledge, understood as technical competence and 'functional literacy'. Instead, it sought contextualised research knowledge informed by the 3D perspective of technoliteracy as social practice.

The site studies

The aim in the site studies was to research, describe and analyse practices in a range of exemplars. By 'exemplars' we did not necessarily mean 'best practice' in the sense of ideals to be emulated, although some of the sites did approximate to this meaning of 'exemplars'. Instead, we approached exemplars in terms of informative and illuminating examples of what was going on in learning on an everyday basis across a range of circumstances, policy and resourcing arrangements, and professional knowledge bases.

The 'patchwork quilt' produced describe diverse models and circumstances that colour instances of current practice. The quilt drew on brief, but intensive and highly focused, investigations of eleven research sites - twenty teachers and their classrooms - in three Australian states, who agreed to participate in the project. Selection of sites drew on advice from personnel in state education departments, and on the local knowledge and professional development connections of the investigators. They were located in NSW, Queensland and Victoria. A range of geographical locations were represented: inner city suburbs, outer city suburbs, satellite cites, regional towns and small settlements in rural areas. Classrooms from lower primary to upper secondary were covered. Key learning areas were English, Technology, Studies of Society and the Environment, Science, Maths and the Arts.

We wanted to witness, 'capture' and describe a range of illuminating instances of practice using new technologies in literacy education: looking for telling cases, so to speak. In most cases, data were collected over just three or four days. These data included contextual or background information, artefacts (for example, policy documents and statements, lists of technology resources, descriptions of student

work); audiotapes and transcripts of interviews; and observation notes. Our emphasis was on finding and describing illustrative instances of practice - particular events or episodes that were likely to be similar to other events and episodes, both at that site and at others. The focus of the analysis and interpretation of the data was on what the descriptions could tell us about how to achieve the kinds of practices and outcomes we believe schools should be seeking.

Consequently, our investigations in no way pretend to be exhaustive of all that went on in these sites. Neither do the portraits claim to be representative of practice as a whole in these sites, still less of schools at large. We describe practices as we saw them to illustrate significant points about literacy, technology and learning. This is not the same thing as assigning an essence to what we observed, and it is certainly not to imply that what we did not see in particular instances did not go on elsewhere. The aim was to use portraits of classroom activities for illustrative purposes. The ideas emerging from classroom portraits were then linked to larger patterns and principles which were intended to enhance future practice on a more extensive scale.

So far as possible, we 'triangulated' data from different collection sources – policy documents and other artefacts, interview material, observations - and across different episodes within single sites and between different sites. Consistencies across these variables increased our confidence in the data collected. We also checked our data-based descriptions against diverse reports of research provided by other people in other contexts as a test of likely authenticity and reliability.

We did not attempt to provide genuine ethnographic accounts of the site-based practices, but to interpret what we saw by reference to the best available theory and research. The focus in the study was on what the descriptions can tell us about how to achieve the kinds of practices and outcomes we believe schools should be seeking.

A template was developed for writing the sites studies. The components were: the study at a glance; the site; the policy context; the practice; distinctive features; and issues and implications. We produced detailed accounts of each site (Lankshear et al 1997). Our analysis drew on the theoretical, conceptual and policy aspects of literacy and technology. At the same time, we allowed the data from the site studies to inform and enrich this wider work in a reciprocal way. Just as our analysis of the data was influenced by our wider conceptual and theoretical frameworks, so were these frameworks in turn clarified, refined and enriched by our data.

We identified three broad patterns which we called 'complexity', 'fragility' and 'continuity'. In addition we analysed the data in terms of four principles: 'teachers first', 'complementarity', 'workability' and 'equity'. These patterns and principles were useful for making sense of the site studies; making decisions and judgments about various aspects of what we saw; and helping us to formulate concrete recommendations for future actions. We concluded that the site studies could inform all stakeholders in education in at least three domains: inservice teacher professional development; preservice teacher education; and theoretical guidance for changes in practice and school reform.

With respect to inservice teacher professional development, the enthusiasm of colleagues is crucial to successful integration of technologies into the curriculum. However, reliance on a few enthusiastic individuals can lead to fragility. Little short of a major change to a school culture is necessary if teachers are to help students develop technological literacies. The domain of preservice teacher education is crucial – a sound basis in information technologies and their educational implications must become a compulsory and effectively handled feature of teacher education programs. Finally, the patterns and principles are able to serve as guides to handling the very important cultural and critical dimensions of effective literacies. Relatively little critical emphasis was evident in the sessions observed across the entire project. This may indicate the extent to which classroom practices involving new technologies are being exhausted on merely getting to grips with the operational dimensions. If this is what is happening it is perfectly understandable – given the relatively limited prior experience many teachers have with communication and information technologies. But it reinforces the importance of attending to all the patterns and principles identified here within future policy directions, teacher education programs and professional development initiatives.

Difficulties facing researchers in literacy and technology studies

The *Digital Rhetorics* project represents, perhaps, a watershed in the research literature. Yet, to some extent, knowledge in this area remains incomplete. One explanation is that the field is volatile and the political, social and cultural influences complex. Another is that 'doing' literacy with communication and information technologies is so new and dynamic that investigation is difficult.

This field is characterised by rapid change. As new sites for research emerge, 'sites' that are virtual and boundless, researchers are faced with the challenge of how to investigate them effectively. To continue to meet the demands of the new research contexts in this chameleon field, researchers need to be wary of nominating as necessarily better or more desirable particular research approaches. Researchers should also avoid naturalising whatever is the current favoured methodological approach as the most progressive. Researchers require flexible, sensitive frameworks for understanding and portraying the complex phenomena of computer-mediated literacy settings.

Future directions

We have reached what could be called a maturing of the field of literacy and technology research. The growth of a multi-method approach has strengthened the understanding that different perspectives offer different 'truths' and that future research can be enriched by hearing multiple voices. We are in the process of developing ways of understanding the connections between literacy practices and the uses of the new electronic technologies that are both 'structured *and* dynamic' (Snyder 1995, p. 57).

The research agenda is fertile with possibilities. In the first instance, researchers should build on previous investigations, adding to the growing knowledge base about the connections between literacy, technology, curriculum and culture. The *Digital*

Rhetorics project has made important inroads into the systematic investigation of these complex phenomena, but we need to know more. We know that the introduction of computers into literacy curricula is a contextual change that encourages alterations in the political, social and educational structures of systems, but we need to look more closely at how. There needs to be more research into how English departments and individual teachers integrate computers into curricula and how computers interact with the whole school curriculum. How does pedagogy change? Do teachers' expectations alter? What are the implications for teachers' professional development and for the training of preservice teachers?

Digital Rhetorics was essentially a qualitative study with the researchers visiting sites, often for just three or four days, and describing, then interpreting what they observed. Schools, classrooms and teachers grappling with literacy, technology and learning, however, also provide a site for practical intervention. A study, based on an action research model, in which teachers and researchers collaborate to implement the recommendations emerging from the project, evaluate what happens, then refine the recommendations for further implementation, could result not only in enhanced administrative and pedagogical practices, but could also provide a rich source of theory.

It would be salutary to concentrate on students who have grown up with the technologies. A longitudinal approach to the study of young people immersed in computer culture will yield new understandings of computer-mediated literacy practices. As students represent a different generation, one with a different relationship to computers and to print text, we must observe them, ask them questions and listen to their responses.

We know that the use of new technologies has significant implications for communication and representation (Snyder in-press-b). It seems that images are becoming more and more dominant. Kress (1997), for example, argues that changes to semiotic practices involve a greater and newer use of visual forms of representation in many domains of public communication and that the turn to the visual represents a significant change to how we make meanings. The connections between verbal and visual modes of representation provoke a number of important questions about the new literacy practices and formations associated with multimodal texts which have important implications for curriculum and pedagogy. Are graphics and video as informative as, or even more informative than, verbal text? Is it possible to determine whether the image, the sound or the word is the principal carrier of meaning in the text? How do the words, pictures and sound interact to make meaning? How do we recognise and interpret ambiguities created by that interaction?

Research projects aimed at investigating the relationships between the verbal and the visual in communication and representation would also provide opportunities to examine at close hand new literacy practices in real contexts: to observe teachers and students, to discuss the emerging technoliteracy practices with them and to apply to those practices understandings which draw on the work of theorists such as Kress (1997), Bolter (1996) and Bolter and Grusin (1999).

We need more research on patterns of resistance to the new technologies. We need to explore further why teachers who work in environments that have computer facilities remain wary of the use of the technology in their classrooms, despite (or perhaps because) of the fact that we face a future dominated by computer culture. We should also be careful in ascribing to the technology powers it does not possess. If we see computers used in innovative ways we want to be cautious about inferring that there is a cause-and-effect relationship between adopting computers and effective teacher practice (Miller & Olson 1994).

Confronted by the largely uncharted territories of cyberspace in which our students are increasingly the navigators, messier, less certain, more reflexive, multivoiced research texts seem to be a useful way to respond. It is likely, however, that the problem of representation will continue to be complicated by the fluid, metamorphosing, unpredictable nature of the electronic spaces themselves.

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